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# DEVICE FOR MANUFACTURING LIQUID CRYSTAL PANEL

[Abstract]

PROBLEM TO BE SOLVED: To surely pressurize substrates to obtain a specified gap by using a rigid body under atmospheric pressure without causing an uneven contact state.

SOLUTION: While a closed space D is evacuated, flat faces 1a, 2a of pressurizing plates 1, 2 move nearer to each other by the atmospheric pressure and bring the top face 3a of a buffer material 3 in contact with substrates A, B. As a result, the buffer material 3 deforms by compression to make a uniform distance between the flat faces 1a, 2a. By further evacuating, the substrates A, B are uniformly pressurized without adding excess force to the flat faces 1a, 2a of the pressurizing plates 1, 2 through the buffer material 3.

[Claims]

[Claim 1] A device for manufacturing a liquid crystal panel in which two substrates A and B are bonded to each other with high precision and are set between pressurizing surfaces 1a and 2a of pressurizing plates 1 and 2 opposite and parallel to each other and an annular sealing material C disposed to enclose the substrates A and B, a closed space D by contacting circumferential portions of the pressurizing surfaces 1a and 2a to each other is formed, the closed space D and pressurizes the both substrates A and B to obtain a specified gap by the atmospheric pressure are decompressed, and an adhesive E between the both substrates A and B is hardened, the device comprising: constructing the pressurizing plates 1 and 2 of a rigid body; fixedly disposing one pressurizing plate to be unmovable and supporting the other plate to be reciprocated in the direction of contact and movement; fixing a buffer material 3 opposite to the substrates A and B to one of the pressurizing surfaces 1a and 2a; and deforming by compression a top face 3a of the buffer material 3 by surface-contacting the top face 3a to the substrates A and B as the closed space D is decompressed.

[Claim 2] The device of claim 1, wherein one pressurizing plate is the top cover 1 supported to be moved upwardly and downwardly, the other pressurizing plate is the fixedly disposed surface plate 2 to be unmovable, and the buffer material 3 is fixed to the pressurizing surface 1a of the top cover 1.

[Title of the Invention]

Device for Manufacturing Liquid Crystal Panel

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a device for manufacturing a liquid crystal panel used in an LCD, and more particularly, to a device for manufacturing a liquid crystal panel which in two substrates bonded to each other with high precision which are set between pressurizing surfaces of pressurizing plates opposite and parallel to each other and an annular sealing material disposed to enclose the substrates, forms a closed space by contacting circumferential portions of the pressurizing surfaces to each other, pressurizes both substrates to obtain a specified gap by atmospheric pressure by evacuating the closed space D, and hardens an adhesive between the both substrates.

[0002]

[Description of the Prior Art] As a conventional device for manufacturing a liquid crystal panel, for example, one as disclosed in Japanese Laid Open No. 2934438, there is a device for manufacturing a liquid crystal panel according to a vacuum press method, in which a pressurizing surface of one pressurizing plate supported to be movable upwardly and downwardly, the pressurizing surface coming in contact with substrates, is a flexible film; the pressurizing plate is lowered to make the flexible film in contact with an annular sealing material; a closed shape is formed between said one pressurizing plate and the other pressurizing plate, that is, a fixed surface plate; as the closed space is evacuated, the flexible film deforms and is adhered along the substrate to thereby pressurize the both substrates by the atmospheric pressure; and a thermosetting adhesive between

the both substrates is hardened by heating the both substrates in such a state.

[0003]

[Problems to be Solved by the Invention] However, in such a conventional device for manufacturing a liquid crystal panel, since the substrates are pressurized by the atmospheric pressure by using the flexible film, according to a material of the adhesive or rigidity of the flexible film, only the adhesive is not sufficiently pressurized and the both substrates are not pressurized to obtain a specified gap. In addition to the vacuum press method, there is another conventional device for manufacturing a liquid crystal panel according to a rigid body press method, in which pressurizing plates formed of a rigid body move nearer to each other using a mechanical press device and two substrates disposed between the pressurizing plates are pressurized to thereby obtain a specified gap. However, very difficult adjustment is required to move the pressurizing plates nearer to each other in a completely parallel state in order to prevent from coming in contact with only one of the both substrates. In particular, it becomes more difficult as the substrates increase in size, and therefore, in fact, it is impossible to use this conventional device in an apparatus for mass production.

[0004] An object of the present invention as recited in Claim 1 is to pressurize both substrates to obtain a specified gap by using a rigid body under atmospheric pressure without causing an uneven contact state. An object of the present invention as recited in Claim 2 which is added to the object of the present invention as recited in Claim 1 is to simplify a support structure of a top cover and smoothly pressurize both substrates to obtain a specified gap by applying gravity of the top cover as well as atmospheric pressure.

[0005]

[Means for Solving the Problem] In order to achieve the aforementioned objects of the present invention, a device for manufacturing a liquid crystal panel as recited in Claim 1 comprises: constructing the pressurizing plates of a rigid body; fixedly disposing one pressurizing plate to be unmovable and supporting the other plate to be reciprocated in the direction of contact and movement; fixing a buffer material opposite to the substrates to one of the pressurizing surfaces; and deforming by compression a top face of the buffer material by surface-contacting the top face to the substrates according to evacuation of the closed space. In addition to the structure of Claim 1, in the device for manufacturing the liquid crystal panel as recited in Claim 2, one pressurizing plate is the top cover supported to be movable upwardly and downwardly, the other pressurizing plate is the fixedly disposed surface plate to be unmovable, and the buffer material is fixed to the pressurizing surface of the top cover.

[0006]

[Operation]

In the present invention of Claim 1, as the closed space is evacuated, flat faces of pressurizing plates move nearer to each other under atmospheric pressure and a top face of a buffer material is pressurized and comes in contact with substrates. As a result, the buffer material deforms by compression to make a uniform distance between the flat faces. By further evacuation, the substrates are uniformly pressurized without adding excess force to the flat faces of the pressurizing plates through the buffer material. In the present invention of Claim 2, a construction that one pressurizing plate is the top cover supported to be movable upwardly and downwardly, the other pressurizing plate is the surface plate fixedly disposed to be unmovable, and the buffer material is fixed to the

pressurizing surface is added to the construction recited in Claim 1. Accordingly, as the closed space is evacuated, the top cover is lowered by the atmospheric pressure and gravity of the top cover to thereby pressurize and contact the top face of the buffer material to the substrates. As a result, the buffer material deforms by compression to equalize thickness ununiformity between the pressurizing surface of the top cover and the substrates. By further evacuation, the pressurizing surface of the top cover formed of the rigid body uniformly pressurizes the substrates along the pressurizing surface of the surface plate without excess force in all direction being applied thereto.

[0007]

[Embodiment of the Invention] The preferred embodiments of the present invention will now be described in detail with reference to the accompanying drawings. As illustrated in Figure 1 and Figure 2, one pressurizing plate is a top cover 1 supported to be movable upwardly and downwardly, the other pressurizing plate is a surface plate 2 fixedly disposed to be unmovable, two glass substrates A and B bonded to each other with high precision in the air are set on the surface plate 2, and the top cover 1 is lowered to be in contact with an annular sealing material C, a closed space D enclosed by the annular sealing material C is formed between the top cover 1 and the surface plate 2, and an adhesive E formed of thermosetting resin between the substrates A and B is heated and hardened.

[0008] The top cover 1 is composed of a rigid body such as carbon, and is supported to be freely reciprocated by a lifting/lowering device such a driving cylinder not illustrated in the drawing. At least after the top cover 1 is lowered and comes in contact with an annular sealing material C, a link with the lifting device is released and therefore can move up and down.

[0009] In addition, the buffer material 3 to come in contact with the substrates A and B is adhered to a pressurizing surface 1a of the top cover 1. The buffer material 3 is composed of a material having excellent thermal resistance (above 100˚C), such as silicon rubber foam or a material having better durability than it such that the buffer material 3 hardens the thermosetting adhesive E.

As for the thickness, when the pressurizing surface 1a of the top cover 1 is in contact with the annular sealing material C, the top face 3a does not come in contact with an upper end surface of the substrates A and B with a gap interposed therebetween. At the same time, when the top cover 1 can be pressurized by atmospheric pressure as the closed space D enclosed by the annular sealing material C is evacuated, the top face 3a deforms by compression by contacting the top face with the upper end surface of the substrates A and B, as shown in Figure 1(b).

[0010] In addition, a heating/cooling unit 4 is installed between the pressurizing surface of the top cover 1 and the buffer material 3. In order to insulate the heating/cooling unit 4, the top cover 1 is formed of a material having excellent insulation. Though not illustrated, an insulating material may be interposed between the pressurizing surface 1a of the top cover 1 and the heating/cooling unit 4. In case of the present embodiment, a platy heater that radiates by being conducted and a metal plate having a plurality of cooling pipes through which coolant passes are stacked to have a sheet shape.

[0011] In the present embodiment, a buffer material 3a' softer than the annular sealing material C is installed at a circumferential portion opposite to the annular sealing material C of the pressurizing surface 1a of the top cover 1. When the top cover 1 can be lowered under atmospheric pressure since the closed space C is

evacuated, the buffer material 3' deforms by compression before the annular sealing material C. Then, the top face 3a of the buffer material 3 comes in contact with the upper end surface of the substrates A and B, and deforms by compression.

[0012] The substrates A and B include a color filter and a TFT substrate having a desired pattern thereon. The adhesive E of a thermosetting resin is used in one of the substrates. The adhesive E is coated in a shape of a frame whose part is opened as an injection hole E1. A plurality of spacers F are dispersed onto one substrate. Then, the substrates A and B are position-aligned with high precision in the air and are bonded to each other. Though only one frame generated by the adhesive E exists as illustrated in Figure 1 and Figure 2, but, not limited to this, a plurality of frames formed by the adhesive E may be disposed between the substrates A and B if the substrates A and B has a large size.

[0013] The surface plate 2 is integrally formed of a heat resisting material, e.g., carbon, that has high rigidity and the same degree of a rate of thermal expansion as the substrates A and B. The surface plate 2 a thickness such that it does not easily deform though the surface plate 2 is heated or cooled by a heating unit 5 or a cooling unit 6 which is buried therein.

[0014] The heating unit 5 and the cooling unit 6 are buried closely to each other on the plane. In the present embodiment, as shown in Figures 1 and 2, the heating unit 5 and the cooling unit 6 having a linear shape as a plurality of lines are alternately disposed at upper and lower middle of the surface plate 2 in the horizontal direction by a predetermined pitch such as 50 to 60mm. A linear heater which radiates by being conducted is used as the heating unit 5. A cooling pipe through which coolant passes is used as the cooling unit 6.

[0015] In addition, since an outer edge portion radiates and thus is likely to be cooled down in comparison to the center portion, a temperature of the heating unit 5 is set such that heating temperature increases from the center portion toward the outer edge portion. The entire pressurizing surface 2a of the surface plate 2 is controlled at uniform temperature.

[0016] In addition, the annular sealing material C such as O ring is opposite to the pressurizing surface 1a of the top cover 1 and is mounted on the pressurizing surface 2a of the surface plate 2. The substrates A and B are set at a fixed position inside the annular sealing material C through a position determining means (not illustrated) such as a frame. A suction path 2b is installed in the surface plate 2 so as to communicate with a space between the annular sealing material C and the substrates A and B. Suction and exhaust are performed from the inside of the annular sealing material C.

[0017] Next, the operation of the device for manufacturing a liquid crystal panel will be described. First, as an initial step, the surface plate 2 is maintained at a temperature which does not affect the adhesive E, for example, below 60°C, the top cover 1 is lifted up, and the substrates A and B are set on the surface plate 2. Thereafter, as shown in Figure 1(a), the top cover is lowered by gravity or by the driving of the cylinder to thereby come in contact with the annular sealing material C, whereby the closed space D enclosed by the annular sealing material C is formed between the top cover 1 and the surface plate 2.

[0018] Thereafter, suction and exhaust are started from the suction path 2b of the surface plate 2, and the closed space D is evacuated. Thus, as shown in Figure 1(b), the top cover 1 is slowly lowered under atmospheric pressure, and the top face 3a is pressurized and comes in contact with the substrates A and B and

deforms by compression. As a result, regardless of flatness of the pressurizing surface of the substrates A and B, thickness ununiformity between the pressurizing surface 1a of the top cover 1 and the upper end of the substrates A and B is equalized. Accordingly, the substrates A and B can be completely parallel to each other and be pressurized surely to obtain a specified gap.

[0019] In addition, according to evacuation of the closed space D, air remaining between the both substrates A and B, more specifically, air remaining inside air E 2 for sealing liquid crystals which is enclosed by the adhesive E is removed from the liquid crystal injection hole E1 which is a path formed at part of the adhesive E. Accordingly, the air remaining inside the space for sealing the liquid crystals does not act as a force against pressurization of the substrates A and B, and therefore the substrates A and B can be smoothly pressurized to obtain the specified gap.

[0020] In addition, at a point of time when the substrates A and B are pressurized nearly to obtain the specified gap, the heating/cooling unit 4 of the top cover 1 and the heating unit 5 of the surface plate 2 are conducted to thereby uniformly increase the temperature of the substrates A and B to soften the adhesive E. The temperature control is performed until the specified gap is taken out and hardened.

[0021] At this time, since the surface plate 2 is integrally formed of a heat-resisting material that has high rigidity and the same rate of heat expansion as the substrates A and B, the surface plate 2 does not deform by heat and maintains its shape. At the same time, since the heating units 5 therein are buried closely to each other on the plane, the entire pressurizing surface 2a of the surface plate 2 is uniformly and quickly heated. Accordingly, heat can be uniformly and quickly conducted from the surface plate 2 to the entire substrates A and B.

[0022] After the adhesive E has been completely hardened, the suction and

exhaust from the suction path 2b of the surface plate 2 are stopped, water-cooling is performed by sending water to the respective cooling pipes of the heating/cooling unit 4 of the top cover 1 and the cooling unit 6 of the surface plate 2. Then, the substrates A and B are drawn out by lifting up the top cover 1. Thereafter, the above-described processes are repeated.

[0023] Figure 3 and Figure 4 illustrate another embodiments of the present invention, respectively. In Figure 3, a protrusion portion 1' that takes the place of the buffer material 3 softer than the annular sealing material C installed at the circumferential portion of the pressurizing surface 1a opposite to the annular sealing material C and is harder than the annular sealing material C is extendedly installed at the circumferential portion of the pressurizing surface 1a. When the pressurizing surface 1a of the top cover 1 is in contact with the annular sealing material C, as shown in Figure 3(a), the top face 3a of the buffer material 3 is not in contact with the upper end surface end of the substrates A and B with a gap interposed therebetween. However, when the top cover 1 can be pressurized by atmospheric pressure as the closed space D enclosed by the annular sealing material C is evacuated, the top face 3a of the buffer material 3 comes in contact with the upper end surface of the substrates A and B and deforms by compression with a range that the annular sealing material C is pressed as shown in Figure 3(b), and this construction is different from the embodiment shown in Figure 1 and Figure 2. Other construction is the same as the embodiment shown in Figure 1 and Figure 2.

[0024] Accordingly, since the buffer material 3 is not required to be fixed later if the protrusion portion 1' is integrally formed on the circumferential portion of the pressurizing surface 1a, the top cover 1 can be more easily manufactured in the

embodiment of Figure 3 compared to the embodiment shown in Figure 1 and Figure 2.

[0025] In another embodiment of Figure 4, a structure of the surface plate 2 is divided into an upper member 2c and a lower member 2d as disclosed in Japanese Laid Open No. 2934438, the cooling unit 6 is buried in the upper member 2c, the heating unit 5 is installed in the lower member 2d, and the heating unit 5 of the lower substrate 2d is operated in a state that the substrates A and B are pressurized. The substrates A and B are heated by thermal conduction from the lower substrate 2d with the upper substrate 2c located therebetween, and when cooling the substrates after the heating, the upper member 2d is separated from the upper substrate 2C. The upper substrate 2c is quickly cooled. This construction is different from the embodiment shown in Figures 1 and 2. Other construction is the same as the embodiment shown in Figures 1 and 2.

[0026] Accordingly, in the embodiment of Figure 4, the substrates A and B can be surely pressurized to obtain the specified gap by using a rigid body under atmospheric pressure without causing an uneven contact state like the embodiment of the Figures 1 and 2.

[0027] In addition, in the preferred embodiments, one pressurizing plate is the top cover 1 supported to be movable upwardly and downwardly, the other pressurizing plate is the surface plate 2 fixedly disposed to be unmovable, two glass substrates A and B bonded to each other with high precision in the air are positioned on the surface plate 2 and come in contact with the annular sealing material C by lowering the top cover 1, and the closed space D enclosed by the annular sealing material C is formed between the top cover 1 and the surface plate 2. However, not limited to this construction, in opposition to this, the upper

pressurizing plate is the fixed surface plate, the lower pressurizing plate is the movable surface plate supported to be movable upwardly and downwardly, the closed space D enclosed by the annular sealing material C is formed by lifting up the movable surface plate, the movable surface plate C can be moved upwardly by the atmospheric pressure as the closed space D is evacuated, and the substrates A and B are pressurized through the buffer material fixed to the pressurizing surface of the movable substrate. In this case, the suction path for suction and exhaust is installed at the fixed surface plate, preferably.

[0028] In addition, in the previous preferred embodiments, the thermosetting adhesive E between the substrates A and B is heated and hardened. However, not limited to this, another adhesive such as an ultraviolet hardening may be used.

[0029] [Effect of the Invention] As described so far, the invention of claim 1 recited in the present invention, the closed space is evacuated and the flat faces of the pressurizing plates move nearer to each other by the atmospheric pressure to pressurizing and contacting the upper end surface of the buffer material to the substrates. As a result, the buffer material deforms by compression to thereby equalize the thickness ununiformity between the flat faces of the pressurizing plates and the upper end surface. By subsequent evacuation, since the flat faces of the pressurizing plates uniformly press the substrates in a parallel state through the buffer material without adding excess thereto, the substrates are pressurized surely to obtain the specified gap by using a rigid body without carrying out the two substrates individually. Accordingly, compared to the conventional one in which the substrates are pressurized by the atmospheric pressure with the flexible film interposed therebetween, only the adhesive can be sufficiently pressed regardless of what the adhesive is formed of and therefore the both substrates are

pressurized to obtain the specified gap. In addition, compared to the rigid body press method requires very difficult adjustment to move the pressurizing plate nearer to each other in a complete parallel state in order not to cause an uneven contact state, the invention of claim 1 can correspond to substrates increasing in size without adjustment of flatness and therefore is effective in a mass-production apparatus. In addition, as the closed space is evacuated, air remaining between the both substrates, more specifically, air remaining inside the space for sealing liquid crystals which is enclosed by the adhesive can be taken out from the liquid crystal injection hole which is the path formed at part of the adhesive. The air remaining inside the space for sealing liquid crystals does not act as a force against pressurization of the substrates and the substrates can be pressurized to obtain the specified gap.

[0030] In addition to the effect of invention of claim 1, in the claim 2 invention, as the closed space is evacuated, the top cover is lowered by the atmospheric pressure and gravity of the top cover to thereby pressurize and contact the upper end surface of the buffer material to the substrates. As a result, the buffer material deforms by compression thickness ununiformity between the pressurizing surface of the top cover and the substrates is equalized. Since by subsequent evacuation, the pressurizing surface of the top cover formed of a rigid body uniformly presses the substrates along the pressurizing surface of the surface plate without adding excess force in all direction thereto, a support structure of the top cover can be simplified and the both substrates can be smoothly pressurized to obtain the specified gap with the gravity of the top cover as well as the atmospheric pressure being applied. Accordingly, the entire substrate does not increase in size and manufacturing costs can be reduced. In addition, since the pressurizing surface of

the top cover has the buffer material thereon is not in contact with the substrates, precise flatness is not required and costs for manufacturing the top cover can be reduced.

[Description of Drawings]

[Fig. 1] is a longitudinal front view illustrating a device for manufacturing a liquid crystal panel in accordance with one embodiment of the present invention, wherein Fig. 1(a) shows a state before evacuation and Fig. 1(b) shows when substrates are pressurized by the evacuation.

[Fig. 2] is a cross-sectional plan view taken along line (2)-(2) of Figure 1(a).

[Fig. 3] is a longitudinal front view illustrating a device for manufacturing a liquid crystal panel in accordance with another embodiment of the present invention, wherein Fig. 3(a) shows a state before evacuation and Fig.3(b) shows when substrates are pressurized by the evacuation.

[Fig.4] is a longitudinal front view illustrating a device for manufacturing a liquid crystal panel in accordance with still another embodiment of the present invention, wherein a state before evacuation is shown.

[Explanation of Reference Numerals] A and B substrates, C annular sealing material, D closed space, E adhesive, 1 pressurizing plate (upper top cover), 2 pressurizing plate (surface plate), 1a and 2a pressurizing surfaces, 3 buffer material, 3a top face